TITLE OF INVENTION

A PROCESS FOR GENERATING A COMPUTER IMAGE OF A COATED THREE-DIMENSIONAL OBJECT

Field of the Invention

The present invention relates to a process for the generation of a computer image of a coated, three-dimensional object.

Background of the Invention

The computer-aided, three-dimensional image of an actually existing or virtual three-dimensional object belongs to the prior art. The observer may be given an impression of the optical effect of a single-color coated three-dimensional object (cf. brochure on OPUS software version 3.2 from Opticore). Deviations within optical surface properties prevailing on the object surface and which are the result of various differing sets of coating parameters prevailing at different locations on the object surface during application of a coating layer cannot be represented.

It is desirable to develop a process which is suitable for allowing the representation of such deviations.

Summary of the Invention

The invention comprises a process for the generation of a computer image of a coated, three-dimensional object comprising the steps of, in appropriate order:

(a) applying at least a relevant coating layer on at least two test panels under the influence of a set of coating parameters which differs with respect to each panel,

(b) taking a plurality of measurements of at least one optical surface property as a function of the set of coating parameters selected on application of the relevant coating layer on each panel,

(c) storing the optical data in a datafile with assignment of the relevant set of coating parameters,

(d) facetting the visible surface(s) of a three-dimensional object by computer into a sufficient number of flat polygonal areas each being sufficiently small for the sufficiently accurate description of the surface topography,

(e) assigning the relevant set of coating parameters and associated optical data in each case to each individual polygonal area by computer, and

(f) assembling the polygonal areas into a computer image of the three-dimensional object.

Detailed Description of the Embodiments

The term "relevant coating layer" used in the description and in the claims means the coating layer which is applied under the influence of differing sets of coating parameters in each case and which has an influence (which may be either a major or minor influence) on optical surface properties of the coating or in the influence of which one is interested. The relevant coating layer may be, for example, a primer, a primer surfacer, a base coat, a clear coat or a top coat layer.

A coated, three-dimensional object may be represented in a "virtual" manner with the process according to the invention. The term "virtual" means that the image or the representation of the object exists in digital or electronic format in a computer. The object itself may exist only in the computer in digital/electronic form, or the object may be an actually existing object.

The process comprises substantially a series of steps in three major groupings: (1) determining the optical data (as a function of the set of coating parameters selected on application of the relevant coating layer and optionally, in addition, other relevant criteria), (2) defining the surface topography data of the three-dimensional object; and (3) merging the two datasets to form a computer image of the three-dimensional object. It is irrelevant whether the optical data are determined first or the surface topography. Of course, both must have been carried out before the relevant datasets can be merged. Thus, there is flexibility in the order of performing the steps in the process.

In order to determine the optical data dependent upon the set of coating parameters selected on application of the relevant coating layer, coatings comprising the relevant coating layer are prepared on two or more test panels, with the relevant coating layer being prepared under the influence of a different set of coating parameters in each case, and one or more optical surface properties of interest are measured. The optical data are stored in a datafile with assignment of the associated set of coating parameters.

The test panels are, in particular, flat metal test panels, for example, body steel or aluminium, or of plastic, for example, 10 cm times 15 cm to 100 cm times 100 cm in size conventionally used for test coatings. The test panels may be uncoated or provided with a single-layer or multi-layer precoating. Metal test panels may be provided with, for example, an electrodip-coating layer conventionally used in motor vehicle coating, or with an electrodip-coating layer and a primer surfacer layer. Plastic panels may be provided with a plastics primer.

The coating structure on the test panels may correspond to the coating structure to be applied to the three-dimensional object. It may be a single-layer top coating consisting of the relevant coating layer, or it may be a multi-layer coating wherein one of the coating layers that make up the multi-layer coating is the relevant coating layer. For example, the base coat layer or clear coat layer of a color- and/or special effect-imparting base coat/clear coat two-layer coating may be the relevant coating layer.

The test panels may assume a horizontal or vertical position during the preparation of the coating, for example, during application and drying or curing of the coatings. It is particularly preferred to provide at least two test panels in a horizontal position and at least two further test panels in a vertical position and optionally in each case at least two further test panels in (various) positions arranged between the horizontal and the vertical position with the coating. It is understood that the panels coated in any one position are coated under different sets of coating parameters, but the same sets of coating parameters used, for example, to coat the vertical panels are also used for coating the horizontal panels.

The test panels are coated preferably by spraying, preferably by means of a conventional coating robot. The coating agents used for coating the test panels are conventional water-borne, solvent-borne or powder coating agents. It is preferred if not only the coating agent used to prepare the relevant coating layer, but also all further coating agents used for coating the test panels are identical to the corresponding coating agents used for coating the three-dimensional object.

The test panels are provided with the relevant coating layer under the influence of different sets of coating parameters in each case. The sets of coating parameters comprise groups of individual coating parameters known to the person skilled in the art, which parameters may be interdependent or be mutually independent. In general, some of the coating parameters within the sets of coating parameters are technically interdependent, while others are mutually independent.

Coating parameters (i.e., the conditions under which the test panel is coated) which may have a perceptible influence upon the optical coating result are known to the person skilled in the art. The coating parameters are in particular the type of atomisation and type of atomiser, atomisation parameters, secondary coating parameters, booth parameters and drying or curing parameters.

Examples of types of atomisation are pneumatic atomisation with or without electrostatic support and high-speed rotary atomisation. Depending upon the type of atomisation, atomisers of various designs and sizes may be selected.

Many different models of atomisers are in turn available from numerous manufacturers.

Examples of atomisation parameters in pneumatic atomisation without electrostatic support are fan air throughput, atomising air throughput and flow rate of the coating agent. In the case of pneumatic atomisation with electrostatic support, voltage and current strength are additional atomisation parameters. Examples of atomisation parameters in high-speed rotary atomisation are rotational speed of the bell, shaping air throughput, flow rate of the coating agent, voltage and current strength.

Examples of secondary coating parameters are the number of spray passes for application of a coating layer, object temperature, distance from and angle between the application device and the surface to be coated, spray pattern overlap, track speed of the application device and line speed.

Examples of booth parameters are air temperature, air humidity and air downdraft.

Examples of drying or curing parameters are type of drying or curing such as curing with high-energy radiation, for example, UV radiation and/or thermal curing; in the case of different successive curing steps, the sequence thereof, heating-up rate, object temperature, oven temperature, evaporation time, stoving time, air humidity; in the case of thermal curing, effect of heat with convection and/or infrared radiation.

When the test panels are coated under the influence of different sets of coating parameters, only one, two or more, or all the coating parameters within the individual sets of coating parameters may be varied. Whether one, two or more, or all and which of the coating parameters are varied with the aim of generating a particular number of different sets of coating parameters with which composition of coating parameters, is decided by the person skilled in the art on the basis of the technical problem to be solved by the process according to the invention. When individual coating parameters are varied, the parameters may be selected, for example, within extreme ranges and ranges located therebetween within the coating process conceivable for the object. In any event, a sufficient number of variations in type and/or size of the relevant coating parameters is performed. In this manner, it is for example possible to establish a basis for making estimates or interpolations between the variations actually performed.

The procedure used for coating the test panels will be illustrated by way of example regarding the application of a base coat layer which determines the color shade of a base coat/clear coat two-layer coating, in this example the relevant coating layer, by means of electrostatic high-speed rotary atomisation.

Application may, for example, proceed in each case at a different rotational speed of the high-speed rotary atomiser while keeping all other coating parameters unchanged. For example, 5 test panels may be coated under the influence of different coating parameters (5 per se identical sets of coating parameters, each differing only in the rotational speed of the high-speed rotary atomiser, for example by varying the speed in intervals of 5000 between 30000 and 50000 revolutions per minute). In this manner, it is for example possible to establish the basis for determining the influence of differing rotational speeds in high-speed rotary atomisation upon the color shade of the two-layer coating.

The coatings applied to the test panel(s) are measured in terms of optical surface properties in the conventional manner known to the skilled person. The term "measurement" includes not only the measurement of optical data with measuring instruments but also purely visual assessments.

Examples of angle-independent optical measurements which may be performed in the process according to the invention are the visual determinations of pitting and sagging limits known to the skilled person, colorimetric measurements on single-color coatings, and measurements of the surface structure. The latter may be performed, for example, with the photometric method known to the skilled person and based on the principle of light reflection modulated by surface structures. All the conventional measuring instruments known to the skilled person may be used, for example, the Wave-scan® sold by BYK-Gardner.

Depending on the optical surface property to be determined, the measurements may be angle-dependent measurements. Angle dependence means dependence on the illumination angle and/or the observation angle. In a first embodiment of angle-dependent measurements, the measurement is performed at a constant illumination angle and varied observation angles. In a second embodiment, the observation angle remains constant during the optical measurement, and the illumination angle is varied. In a third embodiment, both the observation angle and the illumination angle are varied during the measurement. Examples of angle-dependent measurements which may be performed in the process according to the invention are colorimetric measurements, particularly on special-effect coatings and gloss measurements.

The procedure used to take angle-dependent colorimetric measurements of coated test panels is known to those skilled in the art. The colorimetric measurement may be an angle-dependent direct determination of RGB values (red-green-blue values) with a color camera for example serving as the measuring instrument. The measurements are carried out preferably, however,

as gonio-spectrophotometric measurements, wherein RGB values may be obtained indirectly.

In gonio-spectrophotometric colorimetry, the reflectance curves of the visible light in the range from, for example, 380 to 800 nm are determined at various observation angles. The determination of the reflectance curves may be carried out for any number of different observation angles. For the purpose of colorimetric measurements on special-effect coatings, a determination at, for example, 5 observation angles of for example 15, 25, 45, 75 and 110° to the specular reflection is generally sufficient. From these points, the reflectance curves for other observation angles can be determined by extrapolation with good accuracy.

When carrying out colorimetric measurements with a fixed illumination angle, the illumination angle is preferably 45° to the perpendicular. When carrying out colorimetric measurements where the illumination angle varies, there may be used any number of different illumination angles. Measurements at, for example, 4 illumination angles of for example 15, 25, 45 and 75° to the perpendicular are generally sufficient because, from these points, the reflectance curves for other illumination angles can be determined by extrapolation with good accuracy.

In colorimetry, light with a known spectral intensity distribution, preferably polychromatic light, is used for illumination. Examples of polychromatic light include, white light, diffuse daylight (standard illuminant D65), neon light (F illuminants) or incandescent lamp light (standard illuminant A). *See, e.g.*, International Commission on Illumination, Publication CIE No 15.2, 1986, Central Bureau of the CIE, A-1033 Vienna, P.O.Box 169, Austria or G.Wyszecki, W.S.Stiles, Color Science, Wiley, New York, 1982, the disclosures of which are incorporated herein by reference. From the reflectance curves obtained by using a given illumination source, it is possible to calculate the color locations resulting for other desired illuminants, for example, the customary colorimetric parameters in the CIELab system L* (lightness), a* (red-green value), b* (yellow-blue value) and hence also C* (chroma) and h*(hue). *See* DIN 6174. From the reflectance curves (or the colorimetric parameters L*, a*, b*, C* and h*) it is possible to calculate RGB values by transformation, for example, using suitable mathematical algorithms. *See* Yevgeny Vishnevsky, Introduction

to Color (Java), 1997 Master's Project, www.cs.rit.edu/~ncs/color; Wyszecki, et al. Color Science, Wiley, New York, 1982; and M.D.Fairchild, Color Appearance Models, Addison-Wesley, Reading, 1998, the disclosures of which are incorporated herein by reference. Conventional colorimetry instruments known to the skilled person, for example, the X-Rite® MA 68 sold by X-Rite Company can be used to determine the reflectance curves.

Irrespective of the choice of observation angle and/or illumination angle, the colorimetric measurement may take place with any arrangement of measuring direction, but in the case of test panels coated in a more vertical or in the vertical position and hence under the influence of gravity it may be expedient to measure in at least one defined measuring direction, for example, crosswise, parallel and/or anti-parallel to the axis of the test panel which was aligned in the direction of gravity during coating.

Gloss measurements may be carried out by conventional goniophotometric methods based on the principle of light reflection known to the skilled person. The gloss measurement may take place at one or more different angles, preferably 20° to the perpendicular. All the conventional gloss meters known to the skilled person may be used, for example, the Microgloss® and Micro-Tri-Gloss® sold by BYK-Gardner.

The optical data are stored in form of a datafile with assignment of the set of coating parameters selected during the preparation of the relevant coating layer and optionally, in addition, the position of the test panels prevailing whilst the coating was prepared. If desired, the type of test panels concerned (type of material and, optionally, type of precoating) may also be assigned and stored. In the case of colorimetric data, the illuminant used during colorimetry may be assigned and stored. Optical data determined as a function of angle, such as, for example, colorimetric data determined as a function of angle, for example, reflectance curves, or L*, a*, b*, C*, h* values or RGB values and gloss values are stored with additional assignment of the corresponding illumination angles and/or observation angles. The data may be entered manually or, as far as possible, entered directly from the relevant measuring device into the datafile.

In the process according to the invention, coated three-dimensional objects, particularly motor vehicle bodies or motor vehicle body parts are represented. The three-dimensional objects may be actually existing objects or, in

particular, objects which exist only as a computer-generated object. The three-dimensional objects exist as three-dimensional objects defined by their computer aided design ("CAD") data. CAD data records of three-dimensional objects may be created with conventional, commercially available software, such as CATIA from Dassault, Pro/Engineer from ICEM/Surf or Alias Wavefront from Silicon Graphics. For the purposes of the process according to the invention, a CAD data record which is suitable for describing the topography (i.e., form design) of the visible surfaces of the three-dimensional object concerned is sufficient. The CAD data record may be newly created accordingly, or generated from a complete CAD data record of the three-dimensional object by reduction. The reduction may be carried out with the same software as that used to create the CAD data records.

The visible surfaces of the three-dimensional object are surfaces visible to the observer, particularly directly visible surfaces. By way of example, in the context of an automobile body, such visible surfaces include the exterior surfaces of the automobile body and surfaces such as door sills. Internal surfaces of the vehicle, such as, for example, the motor space, the passenger space or the trunk are preferably not taken into account, nor are the internal surfaces of hollow spaces.

The visible surfaces defined by the CAD data of the three-dimensional object may be facetted by computer using commercially available virtual-reality software suitable for the realistic representation of surface topographies into a sufficient minimum number of flat polygonal areas (polygons) each being sufficiently small for the sufficiently accurate description of the relevant surface topography. Examples of suitable virtual-reality software include OPUS software from Opticore or AMIRA software from Indeed Visual Concepts.

The polygons are joined together by common edges. The type of polygons is, in principle, arbitrary. Various types of polygons may be combined for the realistic representation of the surface topography; the polygons are preferably exclusively triangular areas joined together by common edges.

The minimum number and the respective areas of the polygons depend on the degree of complexity of the surface topography of the visible surfaces of the three-dimensional object and the desired accuracy of the computer image in the process according to the invention. The sum of all the polygonal

areas corresponds, in a close approximation, for example, with a deviation in the region of not more than ± 2 %, to the surface area of the visible surface(s) of the three-dimensional object. For example, 30,000 to 300,000 polygons are generally sufficient as the minimum number for the accurate description of the surface topography of a motor vehicle body. Of course, the number of polygons selected may be above the minimum number, for example, 50,000 to 3,000,000 polygons in the case of a motor vehicle body. In principle, the number of polygons selected may be any number above the minimum number, the accuracy of the computer image increasing with increasing number, albeit tending to a limiting value. A further increase in the number of polygons does not, in practice, lead to a further increase in accuracy discernible by the observer. It is expedient, therefore, to select a number of polygons above the minimum number which is in reasonable proportion to the computer capacity available.

The polygons have sufficiently small areas. All the areas may be the same size or different. The individual areas lie in a range of values from, for example, 1 square millimeter to 1 square meter. The more complex the surface topography, the smaller should be the area of the polygons selected. In the case of three-dimensional objects with regions of simple (no curvatures or only slight curvatures with up to infinite radius of curvatures per unit of area) and complex surface topography (many curvatures and/or pronounced curvatures per unit of area with a small radius of curvature, corners, beads, edges), it is expedient to facet these into polygons of different areas, i.e. regions of simple surface topography are facetted into polygons with areas within the upper range of values, areas of complex surface topography into polygons with areas within the lower range of values. For example, regions of simple and complex surface topography may be present on the visible surface of a three-dimensional object or on the visible surface of one or more components joined together to form a three-dimensional object, or the three-dimensional object is joined together from components with a simple surface topography and components with a complex surface topography.

Each polygon has a position in space. This position may be defined by means of the area center of gravity of the polygon concerned and its normal in space. Each of these area centers of gravity may be defined clearly, for example, by X,Y,Z coordinates in a Cartesian coordinate system and the position of each of

these normals in space by means of their three angles, based on the Cartesian coordinate system. The position of an observer may be defined by X',Y',Z' coordinates or by X'_{left}, Y'_{left}, Z'_{left} and X'_{right}, Y'_{right} and Z'_{right} coordinates for the left and the right eye of an observer, and the position of one or more (n) illumination sources by X''_1, Y''_1, Z''_1 to X''_n, Y''_n, Z''_n coordinates in the same Cartesian coordinate system.

Whilst a three-dimensional object is being coated, the conditions are not the same at all locations on the object surface with regard to the coating parameters or sets of coating parameters which apply during coating. Rather, sets of coating parameters which are different but constant at fixed locations exist for different locations on the surface. The reasons for this are, for example, the object geometry itself, particularly with three-dimensional objects having a complex shape, deliberately planned differences in the sets of coating parameters at different locations on the surface, and a deliberately planned dynamic change in coating parameters taking place during the coating process. The resultant distribution of differing sets of coating parameters which apply on the surface of the object during coating may cause perceptible differences in the optical coating result on an object.

A set of coating parameters may be assigned to each individual polygon or to groups of polygons joined together by common edges. The person skilled in the art here selects the sets of coating parameters to be assigned dependent on the technical problem to be solved by the process according to the invention. It is, for example, possible to simulate the impact of variation in the nature and/or size of individual coating parameters upon the optical coating result.

In accordance with what has been stated in the preceding paragraph, the process may be performed in three different ways:

a) A per se constant set of coating parameters is defined which, in particular on the basis of the object geometry itself, gives rise to locally differing sets of coating parameters on the object surface. Different sets of coating parameters are accordingly assigned to different polygons or groups of polygons joined together by common edges.

b) Deliberately different sets of coating parameters are defined for different points on the object surface and are accordingly assigned to the polygons or groups of polygons joined together by common edges. The deliberate

differences in the sets of coating parameters may here simply be different coating parameters for different locations on the object surface and/or coating parameters which are dynamically modified during the coating process.

c) Combination of a) and b).

The person skilled in the art may assign the various sets of coating parameters with regard to the nature and/or size of coating parameters on the basis of precise knowledge and/or on the basis of experience and/or precise estimates with regard to individual coating parameters.

The various sets of coating parameters may be assigned to the polygons in such a manner that the assignment corresponds to the sets of coating parameters prevailing during coating of the object or is suitable at least substantially to simulate the optical coating result achievable with the sets of coating parameters prevailing during coating of the object. It is thus possible, for example, with a given object, a given coating agent for the production of the relevant coating layer and a knowledge of the sets of coating parameters prevailing upon a given object in a given coating process, to make a prediction as to the optical coating result. Alternatively, it is possible to take as basis an existing coating plant, some of the sets of coating parameters for which are predetermined, or an as yet non-existent coating plant for which there is still very large freedom of choice in the definition of coating parameters or sets of coating parameters. It is possible here to define different sets of coating parameters for different locations on the object surface and the resultant optical coating result may be simulated.

By virtue of knowing the set of coating parameters for each individual polygon, the computer is able, in turn, to assign to each individual polygon the relevant optical data of interest which correlate to the relevant set of coating parameters.

If the optical data are for surface properties which can be perceived differently as a function of the position of an observer, the computer may also, by virtue of knowing the position of each individual polygon, assign to each individual polygon a viewing angle dependent on the position of the observer, and illumination angles dependent on the position of one or more illumination sources, and the optical data, for example, colorimetric data, that correlate with these.

Likewise in order to increase the accuracy of the computer image in the process according to the invention, it may be expedient if the computer, when

making this assignment, also takes account of the nature of each polygon (type of material, for example, in the case of three-dimensional objects composed of different materials; type of any precoating) and selects accordingly from the stored optical data differentiated according to type of test panel.

In order to increase the accuracy of the computer image in the process according to the invention, it may also be expedient if the computer, when assigning the optical data, takes account of the position of each individual polygon (when positioning the three-dimensional object, according to the position obtaining during the preparation of the coating on the three-dimensional object in reality) and selects accordingly from the stored optical data differentiated according to the position of the test panels obtaining during the preparation of the coating. When the position of each polygon is taken into account, this is carried out advantageously in such a way that the optical data available for a test panel coated in a horizontal position are assigned to polygons with a more horizontal position, whereas the optical data available for a test panel coated in a vertical position are assigned to polygons with a more vertical position. If optical data are available for test panels coated in a position between the horizontal and vertical, the same applies.

Optical data may thus be assigned by computer to each polygon and a computer image generated by assembling the polygons provided with the assignment. An individual, optical surface property or a combination of at least two optical surface properties may be represented with the computer image.

The computer image may be generated in a visually perceptible manner as a realistic representation or as a scaled coded representation, for example, as a false color representation or as a representation with various grey levels or different patterns. The computer image may also, however, be generated as a computer image existing only as a set of data. Which type of computer image is more advantageous in the individual case depends on the type of optical data considered and on the optical surface property(properties) to be represented, or on the technical problem which is being monitored with the evaluation of the computer image.

If the optical surface property measured in the process according to the invention is, for example, the impression of color and/or special effect, this may be represented visually in a realistic manner as an impression produced on

the three-dimensional object by assigning to each polygon a fundamental color defined by RGB values obtained from corresponding colorimetric measurements, each polygon being represented by pixels in each case composed of a triple combination of red-green-blue. Gloss reflections may be reproduced by varying brightness or contrast of the pixels of the polygons concerned. By assembling the polygons, the object may be represented three-dimensionally in the corresponding visually perceptible impression of color.

The generation of the computer image is not confined to the reproduction with an illumination with the illuminant used during the optical measurement, for example, during colorimetry. As explained above in connection with colorimetry, the colorimetric data are available independently of the illuminant used during colorimetry, or may be calculated if the illuminant used for illumination during colorimetry is known. The generation of the computer image may be carried out with simulated illumination with one illumination source or with several illumination sources of any spectral intensity distribution in the range of visible light by calculating the RGB values from the reflectance curve determined and stored during colorimetry with illumination with a known illuminant. In the event of several illumination sources, these preferably have an identical spectral intensity distribution in each case.

The object as a whole or a section of the object may be represented, for example, by means of a conventional zoom function. For the purposes of the process according to the invention, the use of a conventional personal computer (for example, Pentium III, 600 MHz with 3D graphics card) is sufficient in practice. Of course, computers with a higher computing capacity may be used to advantage.

The computer image may be carried out according to the visual impression produced in diffuse or directed illumination with one or more illumination sources.

The visually perceptible, realistic computer image or computer image existing in the form of a scaled, coded representation may be generated with all the conventional virtual-reality techniques. The term three-dimensional representation should be taken to mean not only the form of a true three-dimensional representation but also a two-dimensional, perspective representation.

The two-dimensional perspective image may be carried out in a conventional manner, for example, on a monitor or by means of a projector onto a screen.

The true three-dimensional image may be carried out with the conventional methods for producing stereo images. The offset images required for this, due to the distance between the eyes of an observer, may be calculated by the software by simulation or taking account of positions defined for the left and right eye. The observer may wear, for example, special spectacles as an aid, and observe the three-dimensional computer image on a monitor, on a projection or back-projection screen whereby, depending on the physical principle used, two separate images which together make up a spatial image are shown either simultaneously (observation with pole filter spectacles) or with a high image changing frequency (observation with shutter spectacles). Another alternative is the corresponding image for the observer by way of a head-mounted display (helmet or spectacles) with two separate displays for the left and right eye, or the complete three-dimensional computer image in a virtual-reality cave.

Irrespective of the medium chosen for the three-dimensional computer image, the computer image may be carried out as a static image, film, or as an interactive real-time computer image. In the computer image as a film and particularly in the real-time computer image, it is possible to alter the position of the object to be viewed and/or the position of the observer. Depending on the change in position, the computer carries out a constant reassignment of the optical data, for example of RGB values to each pixel of each polygon. In the real-time computer image in particular, the computer learns the respective relative positions of object and observer and optionally illumination source(s) with the conventional means for the virtual-reality technique used in each case. For example, the observer may simulate a change in relative position by means of a computer mouse, a joystick or a data glove and thus control the computer. The observer may also actually move, however, and inform the computer of the change in relative position by means of a device connected to the observer, for example, by means of a transmitter or a camera which tracks a marking fixed to the observer.

In a representation of the computer image as a scaled, coded representation, polygons to which optical data lying outside a required range are assigned are represented with one or more other codes as polygons with an

assignment of optical data lying within the required range. In this way, different regions of the object surface in terms of position and area may be identified immediately as lying inside or outside the required range of optical surface properties concerned. Required regions, tolerance regions and regions lying outside these can be defined for all the optical surface properties.

It is clear to the skilled person that computer images generated with the process according to the invention may be printed in the form of visually perceptible representations on paper or other materials too.

Whereas a computer image existing as a coded representation may be evaluated visually, a computer image existing only as a data set may be evaluated by computer.

It is possible, with the process according to the invention, to simulate the optical coating result for a three-dimensional object to be coated on the basis of optical surface properties measured on coated test panels.

The computer images may be evaluated, for example, in terms of a desired, e. g. smallest possible deviation of optical data of the polygons. Deviations within optical surface properties caused by different sets of coating parameters which apply at different locations of the object surface during application of the relevant coating layer may be simulated in terms of location and area.

With a given coating for the production of the relevant coating layer and a given three-dimensional object, the process according to the invention may be used as a valuable tool in selecting one or more suitable sets of coating parameters for the production of the relevant coating layer on the object or, in other words, in the development of the coating process. Development of a coating process may mean defining coating parameters or sets of coating parameters within the limits predetermined by an existing coating plant. Development may, however, also mean the true initial design of a coating process for an as yet non-existent coating plant which is consequently not subject to any limits or for which there is still a great degree of freedom in the selection of the sets of coating parameters. Coating tests to be carried out in practice on the object, for example, line trials in body painting plants, may be avoided or their number at least substantially reduced and carried out virtually instead, as a computer simulation. As a rule, a coating process will comprise more than one set of coating

parameters. For example, the process according to the invention may ultimately be used to create a virtual constellation of different sets of coating parameters resolved according to locations on the object surface, which promises the greatest possible consistency with regard to a particular optical surface property over the entire surface of the object.

If computer images generated with the process according to the invention and existing only as a data set are used, the computer evaluation thereof may be used to develop a proposal for a set or sets of coating parameters to be selected for the preparation of the relevant coating layer. For example, by virtue of knowing the specific influence of various coating parameters upon the optical coating result, an optimisation program may interpolate between various computer images assigned to known sets of coating parameters towards an optimum, and work out an associated proposal for sets of coating parameters to be selected.